

# Ten-year analysis of the forest fire smoke in the Russian Far East

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**Abstract**— Forest fires make large quantities of forest resources lost, and promote global warming. In the Russian Far East, since forest fires occur every year, they have had a great influence on the earth environment. Especially, the fire smoke influences the region where a forest fire doesn't occur because it extends more widely than a fire does. In this paper, we examined the extension of the distribution of the forest fire smoke in the Russian Far East for ten years from 1994 to 2003. We used 380 scenes of NOAA AVHRR. The smoke distribution and precipitation were compared about data as which the number of cases and the season of the fire occurrence were almost the same. As a result, the smoke distribution extended terribly when precipitation was a little. And, the influence of precipitation was greater than that of the fire occurrences. We analyzed the number of fire occurrences for ten years. We used 1185 scenes for the analysis. In 1998, precipitation was the least of ten years and there were a lot of fire occurrences. The generated fire smoke extends more widely because the number of fire occurrences increases when precipitation is a little. Therefore, precipitation is very sensitive factor when we monitor the environmental pollution by wide distribution of fire smoke. We examined the relation among the forest fire, smoke, and precipitation, and showed the importance role of precipitation.

## I. INTRODUCTION

Forest fires make large quantities of forest resources lost, and promote global warming. In the Russian Far East, since forest fires occur every year, they have had a great influence on the earth environment. For instance, the area burnt down due to a forest fire in Khabarovsk was 1.5 million hectares or more only a year of 1998 [1]. Especially, the fire smoke influences the region including cities where a forest fire doesn't occur because it extends more widely than a fire does. Moreover, the spark of a forest fire that occurs in the nearby place is carried by the wind with smoke. Therefore, fire smoke is important also for thinking about the cause of a fire.

The detection of the hot spot is important for monitoring a forest fire. However, even if the hot spot cannot be detected, fire smoke can be seen. Therefore, the development of the method of detecting fire smoke can be used for the early warning. We can know the area where a fire occurs by detecting fire smoke.

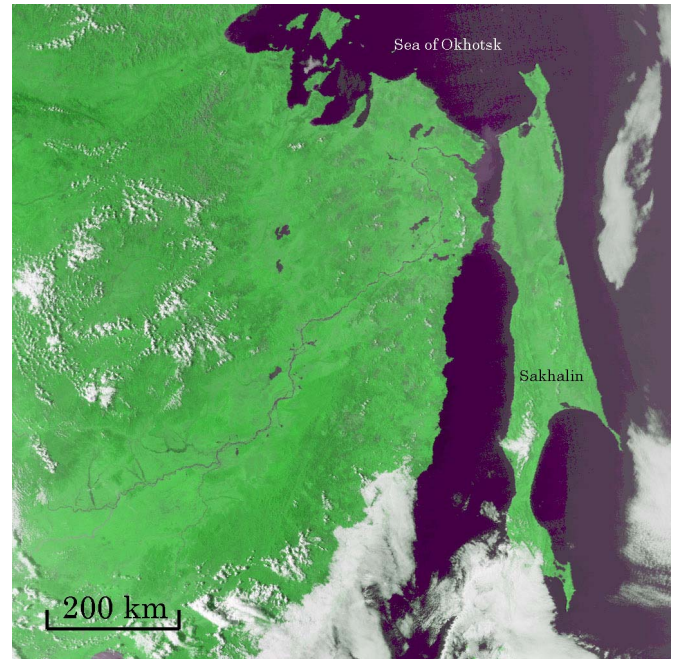


Figure 1. Location of the study area

## II. STUDY AREA AND DATA

In this study, we use NOAA AVHRR images of Sakhalin region which is located in the Russian Far East. Figure 1 shows the location of a study area. It has a part of the Sea of Okhotsk, and the Sakhalin. A forest fire occurs in this region from May through October of every year.

## III. METHODOLOGY

In this paper, we examined the extension of the distribution of the forest fire smoke in the Russian Far East for ten years from 1994 to 2003. We used 380 scenes of NOAA AVHRR. This method is based on the three dimensional histogram method [2] [3]. To explain the feature of the proposal method, Figure 2 is shown. Figure 2 shows the detection result of smoke by the proposal method. The image in the upper row is August 8, 1998, and the lower is August 6, 1998. Figure 2 (a), (b), and (c) correspond to the false color image, Asakuma's

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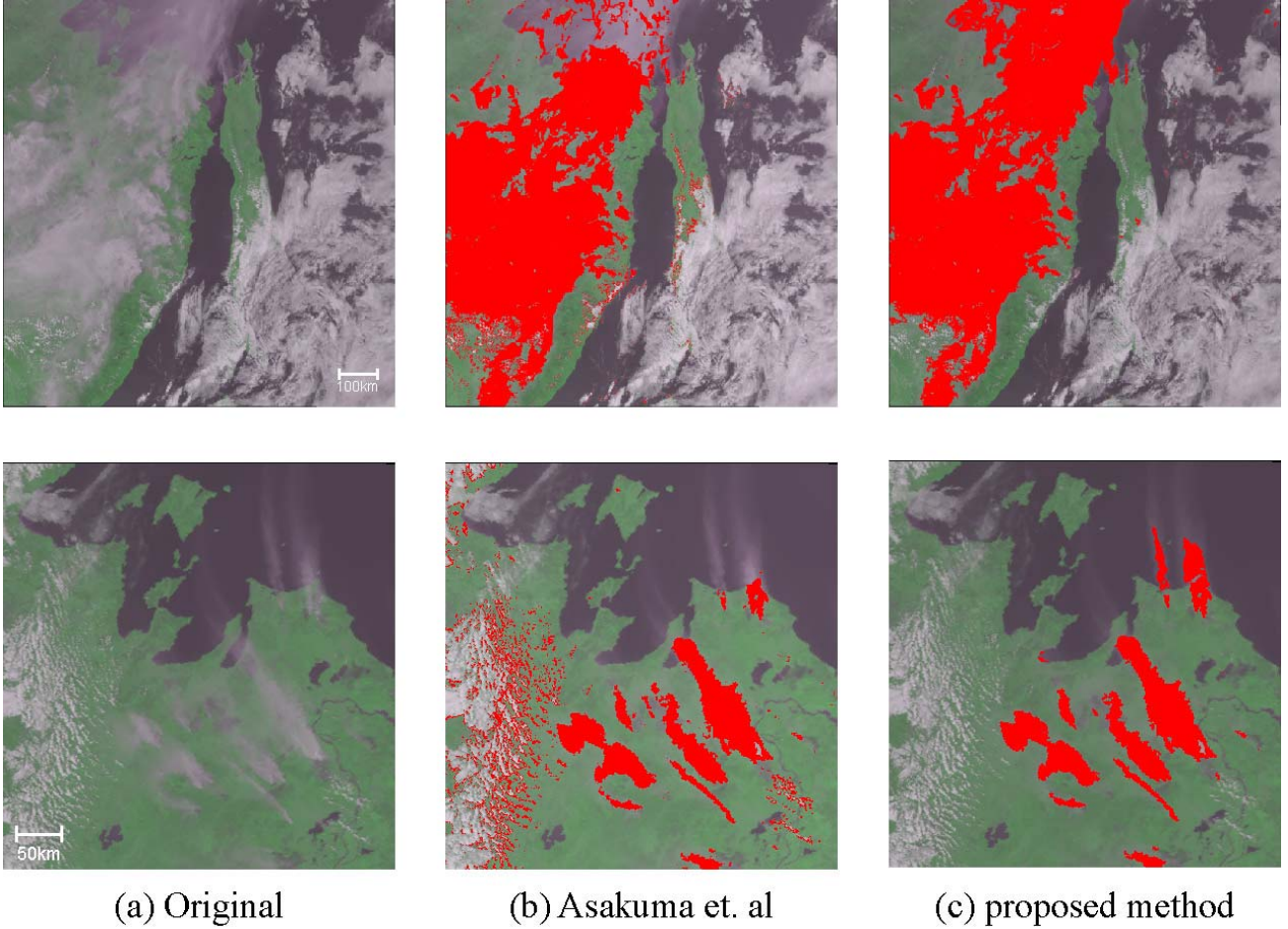


Figure 2. Property of proposed method

traditional method, and the proposal method respectively [4]. As for the proposal method, the error detection of land is fewer than the traditional method, and the detection result on the sea is better. The time series of the image was analyzed by using this proposal method.

#### IV. RESULTS AND DISCUSSION

A large-scale forest fire in the Russian Far East occurs chiefly in summer. And, it is said that the cause of a forest fire is carelessness of the fire by man. The number of detection from May to October was totaled, and it was assumed to be a result.

Figure 3 shows the change in the number of smoke and hot spot. There are a lot of hot spots and smokes in 1998. And the same is true for other years. Number of smoke pixels was relatively more than that of hot spots in 1998. This is because the precipitation in 1998 was the least in the past ten years. To find the reason why smoke increases when precipitation was a little, the relation between precipitation and smoke was investigated. It is necessary to prepare data as which the number of hot spots is the same to compare these. It is because

the amount of the generated smoke is different if the number of hot spots is different.

Figure 4 shows the relation between precipitation and the amount of smoke. And, the number of hot spots of both is made almost the same for the comparison. We have a lot of examples, and this is one example among many.

As a result, there was a lot of precipitation when precipitation was little, and a little smoke when there was a lot of precipitation. It is thought that this is because a part of smoke is absorbed by raining. The amount of smoke will increase extremely if it doesn't rain because the number of hot spots increases when precipitation is a little. The amount of smoke increased for such reasons in 1998. There were not a lot of amounts of smoke in 2003 because precipitation was the same as the usual year though there were a lot of hot spots.

The number of hot spots not only increases when precipitation is a little but also the amount of the smoke generated from the hot spot increases. Therefore, it is important to observe precipitation to prevent a large-scale forest fire from influencing it beforehand.

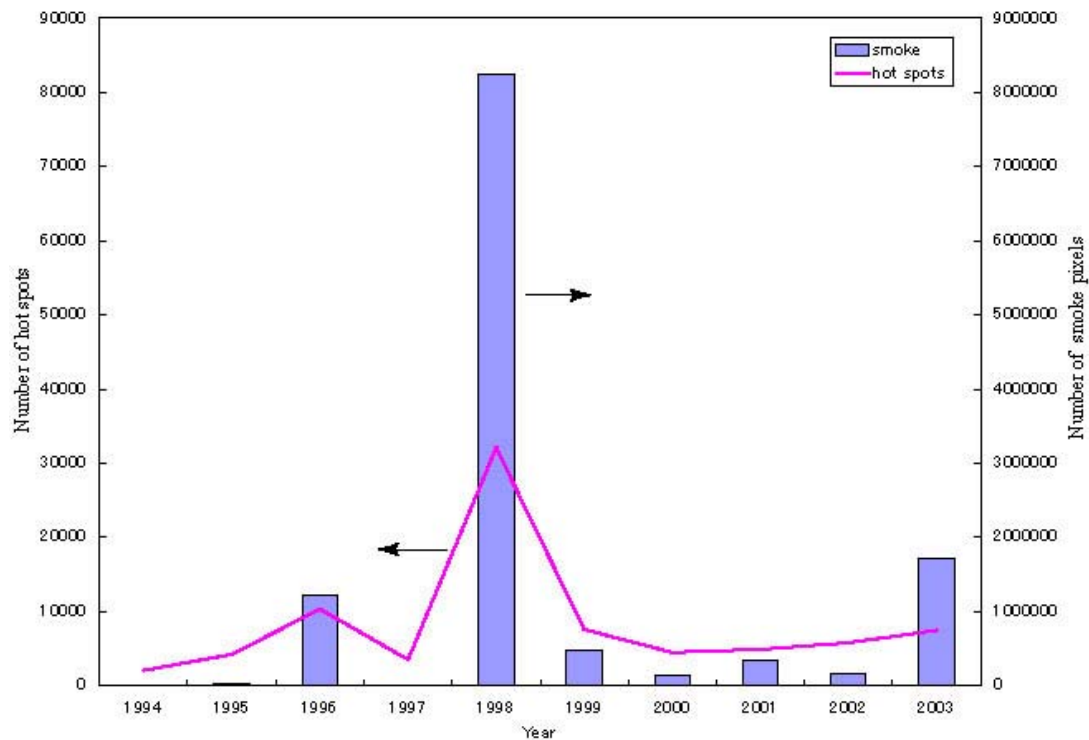


Figure 3. Result of ten-year analysis by proposed method

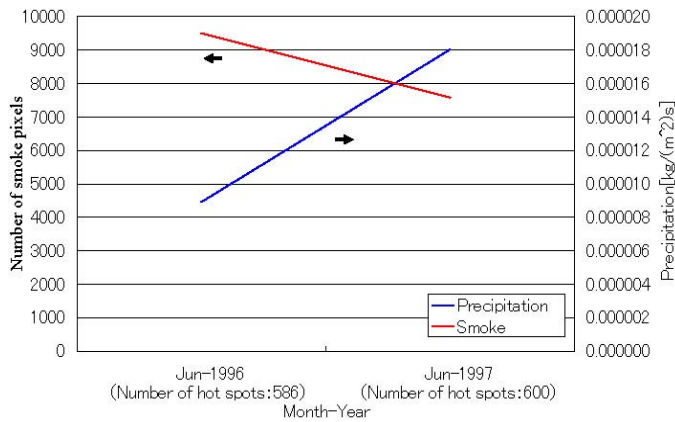


Figure 4. Relations between precipitation and smoke.

## V. CONCLUSIONS

In this study, the forest fire smoke was detected from 1994 to 2003 in the Russian Far East. As a result, the amount of smoke was also large when there were a lot of hot spots of a forest fire. However, the amount of smoke was also abnormally large in 1998 though there were a lot of hot spots. Precipitation was the least in the past ten years in 1998 when the precipitation of each summer was investigated. Then, we compared two data which the number of hot spots is almost equal. As a result, there was a lot of precipitation when

precipitation was little, and a little smoke when there was a lot of precipitation. The amount of smoke increases extremely because the number of hot spots increases when the precipitation of summer is a little. Therefore, we should keep careful watch on forest fire and smoke when the precipitation of summer is a little.

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